Physical hazards in meat products: consumers' complaints found on a Brazilian website

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Abstract

Meat and meat products can be contaminated by physical hazards, which is a big concern for meat industries. The incidence of physical hazards in meat products from 2016 to 2018 in Brazil have been investigated through a website (*Reclame Aqui*) used by consumers to express their dissatisfaction. A total of 408 consumers' complaints were found involving the presence of physical hazards in meat and meat products. The greatest percentage of complaints was found in sausages (fresh, dried, and cooked sausages such as *Linguiça Calabresa*, *Linguiça Portuguesa*, and *Linguiça Toscana*, among others; 33.33%) followed by hamburgers (17.89%), fresh chicken meat (12.25%), and chicken nuggets (9.80%). Fewer consumers' complaints were found in fresh pork meat (0.49%), fresh bovine meat (0.49%), and chopped ham (0.49%). The presence of bones (26.96%) was the major physical hazard found in meat products followed by plastic (25.24%), insect (11.26%), and metal (8.82%). Results indicated that even with quality programs implemented in the industry such as Hazard Analysis and Critical Control Points and Good Manufacturing Practices, sometimes failures on processing line, packaging, commercialization, and service inspection can happen.

Keywords: Food contamination, consumer dissatisfaction, Internet, physical hazards, meat products

1. Introduction

Physical, chemical, and/or microbiological hazards are a big concern for food industries, including meat. Brazil is one of the largest beef, pork, and poultry meat producers in the world; aside from fresh and frozen raw meat, the industry also processes fresh, cooked, and dry fermented meat products (sausages, hamburgers, chicken nuggets, ham, etc.). According to the Brazilian legislation, meat products should be processed under hygienic and sanitary conditions to avoid physical, chemical, and microbiological contamination (Brasil, 2017). The industry has different systems to control the hazards incidents in food processing, such as Hazard Analysis and Critical Control Points (HACCP) and Good Manufacturing Practices (GMP), to improve food safety and quality (Hung et al., 2015; Park, Kim, & Bahk, 2017). The HACCP system has become an important obligation for food companies in both the European Union (European Commission, 2004) and Brazil (Brasil, 1998). Besides HACCP principles, GMP such as an adequate maintenance of a clean condition of all rooms and food contact surfaces intended for food production (Losito et al., 2017), protection against rodents and pests, personal hygiene and training programs, and general use of the standardization of production techniques, visual inspection, and even metal detection techniques (Brasil, 2004; Van Schothorst & Kleiss, 1994) are extremely useful. However, the implementation of quality systems requires considerable investment (Cusato et al., 2014) and eventually may fail, resulting in accidental unwanted items in food, and cause great economic losses for companies and exporting countries.

Some food safety incidents may be caused by the presence of physical hazards. Physical hazards are either foreign materials unintentionally introduced to food products or naturally occurring objects and can cause injury, illness, or psychological trauma to those who ingest them (Aladjadjiyan, 2006). These fragments can be in the form of

glass, metal, rubber, plastic, wood, bones, or any other object larger than 2.0 mm (Batt, 2016; ICMSF, 2018). In South Korea, physical hazards (mainly non-metal materials such as plastic, glass, and insects) were related to 20.4% of 975 food safety incidents that occurred between 1998 and 2016 (Park et al., 2017). Recently, Brazil also faced an incident involving the largest companies accused of intentionally adding paper to meat products, which had an international impact (G1, 2017). Moreover, the presence of any kind of strange object in meat products may cause a dissatisfaction with the companies involved. According to Corlett (1998), about 91% of dissatisfied consumers will never buy again the products or services that displeased them and the cost to attract new consumers is five times higher than to maintain one.

Throughout the years, many companies have a customer assistance service in which consumers report the problems about foods and the industries can find solutions to improve product's quality (Van Asselt, Van Der Fels-Klerx, Marvin, Van Bokhorst-van De Veen, & Nierop Groot, 2017). Nowadays, with the improvement on Internet access and large use of social networks, consumers have started to use digital platforms to expose their dissatisfaction with foods and products in general. In Brazil, the largest platform where consumers can expose their complaints in relation to products (including foods) and services in general is the website *Reclame Aqui*. The website also could be used for the evaluation of different kinds of hazards and the incidents in different kinds of food products. Recently, Aguiar et al. (2018) have used *Reclame Aqui* to quantify the consumers' complaints about physical hazards in dairy products. In addition, Lemos, Garcia, Mello, & Copetti (2018) also used the same platform to analyze consumers' complaints about moldy foods. However, to the best of our knowledge, there are no studies reporting the occurrence of physical hazards in meat products using consumers' complaints found on a website in Brazil and in other

93 countries. Nevertheless, the study of physical hazards incidents in meat products could
94 be useful to industry administration to evaluate the impact of those hazards and take
95 different actions to solve the problems. Thus, the aim of the present study was to collect
96 information about physical hazards in meat products based on complaints from
97 Brazilian consumers found on *Reclame Aqui*.

98

99 **2. Materials and methods**

100 *2.1. Data collection*

101 Data were collected from the Brazilian website *Reclame Aqui*
102 (www.reclameaqui.com.br), where consumers can expose their complaints about
103 products and services in general, making a channel with industries. This website is
104 largely used by the Brazilian population and currently the 27th most accessed website in
105 Brazil (Alexa, 2019). Data collected in this work correspond to January 2016 to
106 December 2018. All the data were quantified and organized according to the type of
107 physical hazard, type of meat products, and year as exposed by consumers on the
108 website.

109

110 *2.2. Statistical analysis*

111 The global chi-square test was used to verify the relation between year and
112 number of complaints by product type, year by hazard type, and meat product by
113 physical hazard. Chi-square per cell was used to identify the source of variation in the
114 global chi-square test. Chi-square test was carried out with Crosstabs procedure and the

115 significance level of 5% ($P < 0.05$) was used. All analyses were performed using SPSS
116 17.0 (SPSS, Inc., Chicago, IL, USA).

117 **3. Results and discussion**

118 A total of 408 consumers' complaints about the presence of physical hazards in
119 meat products found on *Reclame Aqui* were found between 2016 and 2018, involving
120 18 different meat products and 13 physical hazards. However, not all consumers have
121 registered their dissatisfaction, indicating that results may be underestimated. The
122 incidence of physical hazards by meat products and specific years of study is shown on
123 Table 1. The highest number of complaints was reported for sausages (fresh, dried, or
124 cooked sausages such as *Linguiça Calabresa*, *Linguiça Portuguesa*, and *Linguiça*
125 *Toscana*, among others, according to Brasil, 2000a; 33.33%), hamburgers (17.89%),
126 fresh chicken meat (12.25%), and chicken nuggets (9.80%). All the other meat products
127 had consumers' complaints below 4.0%. Probably, the high consumers' complaints in
128 sausages are related to their high consumption per capita of 2,092 kg/hab (IBGE, 2010).
129 The largest number of complaints was related mainly to physical hazards: bone
130 (26.96%), plastic (25.24%), insect (11.26%), metal (8.82%), hair (7.59%), and foreign
131 object (6.84%); the other physical hazards had consumers' complaints below 4.0%
132 (Table 2).

133 The chi-square test allows to see if the complaints were higher (+) or lower (−)
134 than expected for a certain meat product and/or physical hazard according to the year
135 evaluated (Tables 1 and 2). In Table 1, the number of consumers' complaints for
136 physical hazards in meat products by year was quite similar: 135 in 2016, 134 in 2017,
137 and 149 in 2018. In the chi-square test per cell, the consumers' complaints for sausages
138 were significantly higher than the theoretically expected value in 2016 and significantly

lower in 2018, whereas, for fresh chicken meat, lower complaints in 2016 and higher complaints in 2018 were noted. Regarding hotdog sausages, lower complaints were marked in 2018, whereas higher complaints were found for frozen chicken meat in 2017 as well as for chopped ham in 2018. In relation to the type of physical hazards, in the chi-square test per cell, plastic had higher consumers' complaints in 2017 and significantly less complaints were found in 2018 as well as for paper in 2016 (Table 2). No significant differences for bone were found in the years of study. In addition, the chi-square test per cell (Table 3) shows that, for sausages, plastic incidence was higher than the expected value, whereas it was lower for feather, glass, and rubber. For hamburgers, the presence of bone and hair was cited more, whereas metal was less mentioned. In relation to fresh chicken meat, more citations were observed for the presence of feather and less for plastic. In minced meat, the incidence of paper was cited more. For mortadella, the presence of insect and metal was more remarkable and bone was less remarkable. For bacon, the incidence of insect and hair was more remarkable and bone and plastic had lower incidence. In patties, insect was cited more than expected. For meatballs, glass was more noted. In salami, paper and wood were significantly higher; meanwhile, foreign object and stone were cited more for kibbeh. In frozen chicken meat, insect and feather were significantly noted. Finally, in chopped ham and fresh bovine meat, plastic and hair, respectively, were significantly higher than the expected.

Fragments of bones correspond to 26.96% of consumers' complaints (Table 2). In Table 3, this physical hazard was reported 39 times in sausages, 28 times in hamburgers, and 18 times in fresh chicken meat. Fragments of bones in meat products can be considered "naturally occurring objects" but may be injurious if they are in many numbers or in a sharp form. Fragments of bones in sausages and hamburgers may have

originated from failures in deboning or grinding processes. Meat grinding makes bone fragments smaller, but consumers can still perceive them. In poultry processing, deboning is done manually or in an automated system (Barbut, 2014), and optimizing deboning is a concern for the poultry industry for preventing the presence of such physical hazards in the final product and to increase product yield (Daley & Stewart, 2009). In fresh chicken meat, it was possible to observe a high incidence of presence of bones (Table 3) compared to other physical hazards, and this can be dangerous especially when ingested by children. According to Arana, Hauser, Hachimi-Idrissi, & Vandenplas (2001), bones contribute up to 12% of all the foreign objects ingested by children. In addition, fragments of bone are also reported for chicken nuggets (8 times; Table 3). In Brazil, the use of mechanically deboned meat (MDM) in cooked meat products (chicken nuggets, mortadella, hotdog sausages, etc.) is allowed (Brasil, 2000a). This is a kind of waste stream mainly for the poultry industry and it is produced by deboning or the separation of edible tissues on chicken bones and consists of high amounts of ash due to bone components (Saricaoglu, Tural, Gul, & Turhan, 2018). According to Brasil (2000a), the size of fragments of bones in MDM should not exceed 0.5 mm, but some consumers still perceive them in meat products. However, MDM is also largely used in mortadella, but no consumers' complaints were found about the presence of bones. This fact could be related to a more refined meat grinding process done on mortadella processing and possible fragments of bones may be smaller.

It is well known that the use of plastic is very common in the food industry and the presence of plastic components in meat products was responsible for 25.24% of consumers' complaints on *Reclame Aqui* (Table 2). Common sources of plastic can be items such as twines used in packing, plastic sacking, and plastic gloves and even from fragments of utensils used for cleaning equipment. In addition, consumers also reported

189 on *Reclame Aqui* the presence of plastic fragments from materials such as pen, which
190 means a great carelessness when using this material on production areas. The presence
191 of plastic in sausages was the main complaint reported by consumers (Table 3). In fresh
192 sausages, such as *Linguiça Toscana*, the use of plastic seals to separate each sausage is
193 common and consumers reported the presence of those seals inside the sausages, which
194 means production failure in stuffing and sealing processes. In dairy products, plastic
195 represents 11.1% of 515 consumers' complaints on *Reclame Aqui*, involving physical
196 hazards and is generally from packaging and utensils used in some small industries
197 (Aguiar et al., 2018). However, in dairy products, the presence of plastic corresponds to
198 less than half of consumers' complaints about the presence of plastic in meat products.
199 With the increasing use of plastic in everyday applications, many food companies
200 regard plastics as one of the most important causes of physical hazards complaints
201 (Edwards, 2014).

202 Insects such as flies, larvae, and ant were responsible for 11.26% of consumers'
203 complaints on *Reclame Aqui* (Table 2). The presence of insects may cause choking and
204 consumer suffocation. In addition, insects could act as important vectors in the
205 transmission of some infectious diseases including foodborne infections (Pava-Ripoll,
206 Pearson, Miller, & Ziobro, 2015). Li et al. (2018) stated that insects such as flies are
207 important vectors for *Listeria monocytogenes* contamination of raw pork meat in retail
208 markets in China. The greatest number of consumers' complaints about the presence of
209 insects was found in sausages (10 times; Table 3). In addition, in bacon, the presence of
210 insects was the mainly physical hazard reported by consumers. Inadequate pest
211 management can lead to post-contamination once insects and other pests can enter the
212 production area through doors and windows, attracted by the lack of cleaning and

213 sanitization of the facilities and equipment (Souza, Cruz, Moura, Vieira, & Sant'Ana,
214 2008).

215 The presence of metal fragments was responsible for 8.82% of consumers'
216 complaints about physical hazards in meat products (Table 2) with more incidences in
217 sausages (14 times) followed by mortadella (6 times) and fresh chicken meat and
218 chicken nuggets (4 times; Table 3). Metal fragments can be from external meat
219 contamination or due to failures on line production, where pieces of metal may enter the
220 product, such as pieces from the grinder mainly (USDA, 2005). Other types of pieces of
221 metal such as splinters, blades, needles, and staples also can contaminate meat during
222 processing.

223 The presence of hair on the final meat products indicated that there may have
224 been hygiene problems at some processing stage or even carried by ingredients used in
225 the preparation of the products. Hair was responsible for 7.59% of consumers'
226 complaints (Table 2) and its presence was reported 10 times on hamburgers, five times
227 on sausages, 4 times on chicken nuggets, and three times on bacon (Table 3). In bacon,
228 as it can be sold with pork skin (Brasil, 2000b), the presence of hair can be considered
229 as a naturally occurring object related to failure on pig's hair removal. However, in
230 bacon, the incidence of hair was lower than in other meat products commented before.
231 These tendencies were similar that the observed in dairy products, where Aguiar et al.
232 (2018) showed that hair was responsible for 15.2% of 515 consumers' complaints and
233 also was attributed to the failures on GMP on dairy processing.

234 Foreign objects were the components that the consumers were unable to identify.
235 This has corresponded to 6.86% of consumers' complaints (Table 2). Aguiar et al.
236 (2018) showed that, in dairy products, foreign objects might come from ingredients

used in their elaboration, for example, in the product's flavoring step. It is possible that the same situation occurs in meat products, as sausages and hamburgers (products with the large addition of ingredients) showed the highest number of complaints.

In Table 2, feather corresponds to 3.67% of consumers' complaints on *Reclame Aqui*. Feather can be considered as a naturally occurring object resulting especially from failures on poultry's scalding and defeathering processes. In Table 3, the presence of feathers was only related to poultry-meat products such as fresh chicken meat (13 times), chicken nuggets (1 time), and frozen chicken meat (1 time). The presence of feathers may be harmful to consumers, especially if quill was the part of feather found, but the most dissatisfaction about the presence of feather is because it is generally associated with the lack of hygiene during processing.

The presence of paper in meat products corresponds to 2.94% of consumers' complaints (Table 2) mainly in minced meat (4 times; Table 3). Nevertheless, it is interesting to observe the behavior of consumers' complaints about the presence of paper in meat products. No complaints were reported in 2016; however, there was an increase in the following years, with six complaints observed in 2017 and another 6 in 2018 (Table 2). Probably, that increase was related to the Weak Flesh (*Carne Fraca*) Operation that started in March 2017 by Brazilian authorities, where one of the accusations was the intentional paper addition in some kind of meat products (G1, 2017). After finishing all the investigations, it was proven that those accusations were false; however, due to the wide information disseminated by TV, radio, and the Internet, it was possible that the population has been influenced.

Fragments of glass reported from food products are among the most important physical hazards on foods due to the emotive impact on consumers, the reputation of

glass fragments for causing injury, and hence the potential for bad publicity (Edwards, 2014). Glass was responsible for 2.69% of consumers' complaints (Table 2) mainly in hamburgers and fresh chicken meat (3 times; Table 3). In addition, a range of materials can be frequently mistaken for glass such as colorless plastics and salt and sugar crystals (Edwards, 2014). Aguiar et al. (2018) also reported that consumers' might be induced to believe that, especially in sweet condensed milk, sugar crystals are fragments of broken glass.

The presence of stone, fabric, wood, and rubber altogether corresponds to 3.91% (Table 2) of consumers' complaints on *Reclame Aqui*, and there hazards were especially reported for sausages (Table 3). These physical hazards showed less than 2.0% of consumers' complaints each, which is very low in relation to other physical hazards found in meat products. However, in a study conducted by Ababio, Taylor, Swainson, & Daramola (2016) that analyzed the impact of food hazards in school meals from students' report from the Ashanti Region of Ghana, the presence of stones represents more than 60% of students' complaints followed by insects, human hair, and metallic substances. Stones may be incorporated in field crops, such as grains and cereals, during harvesting, but this kind of ingredient is not commonly used in meat products without any kind of pretreatment. The presence of fragments of fabric could be related to the lack of care regarding clothing and uniforms and also demonstrate failures on GMP. Splinters from wood structures and wooden pallets used to store and transport ingredients of food products may be the cause of contamination reported in wood. Finally, in relation to rubber, it may be from the breakdown of some equipment.

It is important to detect and eliminate physical hazards in food. Nowadays, there are several methods available to detect physical hazards in food processing lines, which can be helpful to reduce their incidence. Metal detectors (Tamime, 2009), capacitive

sensors (Mohammadi, Ghasemi-Varnamkhasti, & Gonzalez, 2017), and X-ray equipment (Jooste, Anelich, & Motarjemi, 2014) can be used to detect foreign objects. However, non-conductive materials such as plastic and glass cannot be detected using a metal detection system (Khairi, Ibrahim, Yunus, & Faramarzi, 2018). Zhong, Zhang, Lu, Liu, & Wang (2019) reported a high-speed display-delayed planar X-ray inspection system for the fast detection of small fishbone and stated that this system is very helpful to detect native hazardous material (fishbone) and foreign material contamination (metals, stones, pen caps, etc.) very quickly. Nevertheless, wood, insects, and hair are not detectable by X-ray systems (Li, Liu, Sun, Ma, & Ding, 2015).

Wang, Sun, & Pu (2017) reported the use of terahertz (THz) wave to foreign object detection. THz wave is in the electromagnetic spectrum ranging from 0.1 to 10 THz and can penetrate through and identify a variety of dense and low-density materials. Lee, Choi, Han, Woo, & Chun (2012) use continuous wave-THz imaging to detect high-density (aluminum and granite pieces) and low-density (maggots and crickets) physical hazards embedded in powdered instant noodle, and the results were compared to X-ray imaging. The results showed that THz radiation could identify low-density objects clearly. However, no studies were conducted using THz waves for physical hazards detection in meat products. In addition, high cost may be a limitation of large application of this technology by food industries. Another technology that can be used in the food inspection process is ultrasonic tomography (Khairi et al. 2018).

Conclusion

Sausages, hamburgers, and fresh chicken meat correspond to more than half of the consumers' complaints (63.47%) on *Reclame Aqui* about the presence of physical

hazards in meat products. Bone, plastic, and insects were the most common physical hazards found on meat products (63.46%). It is clear that preventive measures are primordial on the meat processing industry, and quality programs such as HACCP and GMP, besides inspection service, are helpful for physical hazards prevention. It is necessary to improve the training of employees, proper pest control, and adequate machinery maintenance and to stimulate the use of new technologies for monitoring physical hazards in meat products. *Reclame Aqui* is an important tool to connect consumers and industries about food dissatisfaction. Data available on this platform can be useful to help industries to better understand consumers' complaints and identify the most susceptible meat products and most representative physical hazards on a meat processing line. In this context, it can be a tool for industries to improve quality and to ensure safer meat products available for consumers.

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Table 1

Table 1 – Physical hazards incidence in meat products from 2016 to 2018 according to consumers' complaints found on a Brazilian website.

Meat product	Years			Number	Proportion
	2016	2017	2018		%
Sausages	56 (+)[a]	50 (+)	30 (−)[a]	136	33.33
Hamburgers	24 (−)	23 (−)	26 (+)	73	17.89
Fresh Chicken Meat	6 (−)[a]	12 (−)	32 (+)[a]	50	12.25
Chicken Nuggets	12 (−)	12 (−)	16 (+)	40	9.80
Ham	7 (+)	5 (+)	3 (−)	15	3.67
Minced Meat	4 (−)	4 (−)	7 (+)	15	3.67
Mortadella	7 (+)	3 (−)	5 (−)	15	3.67
Hotdog Sausages	6 (+)	6 (+)	1 (−)[a]	13	3.18
Bacon	4	5 (+)	3 (−)	12	2.94
Pattie	2 (−)	3 (+)	2 (−)	7	1.71
Meatballs	3 (+)	3 (+)	1 (−)	7	1.71
Salami	1 (−)	2 (−)	4 (+)	7	1.71
Kibbeh	1 (−)	2	3 (+)	6	1.47
Turkey Breast	1	1	1	3	0.73
Frozen Chicken Meat	0 (−)	0 (−)	3 (+)[a]	3	0.73
Chopped Ham	0 (−)	2 (+)[a]	0 (−)	2	0.49
Fresh Bovine Meat	1 (+)	0 (−)	1 (+)	2	0.49
Fresh Pork Meat	0 (−)	1 (+)	1 (+)	2	0.49
Total	135	134	139	408	100

[a] Effect of chi-square per cell. (+) or (−) indicate that the observed value is higher or lower than the expected theoretical value. *$P < 0.05$.

Table 2

Table 2 – Physical hazards found in meat products from 2016 to 2018 according to consumers' complaints found on a Brazilian website.

Physical hazard	Years			Number	Proportion %
	2016	2017	2018		
Bone	40 (+)	35 (−)	35 (−)	110	26.96
Plastic	33 (−)	43 (+)[a]	27 (−)[a]	103	25.24
Insect	15 (−)	12 (−)	19 (+)	46	11.26
Metal	13 (+)	10 (−)	13 (+)	36	8.82
Hair	14 (+)	8 (−)	9 (−)	31	7.59
Foreign Object	8 (−)	10 (+)	10 (+)	28	6.86
Feather	2 (−)	5 (+)	8 (+)	15	3.67
Paper	0 (−)[a]	6 (+)	6 (+)	12	2.94
Glass	4 (+)	3 (−)	4 (+)	11	2.69
Stone	2 (−)	1 (−)	4 (+)	7	1.71
Fabric	2 (+)	0 (−)	2 (+)	4	0.98
Wood	2 (+)	0 (−)	1	3	0.73
Rubber	0 (−)	1 (+)	1 (+)	2	0.49
Total	135	134	139	408	100

[a] Effect of chi-square per cell. (+) or (−) indicate that the observed value is higher or lower than the expected theoretical value. *$P < 0.05$.

Table 3

Table 3 – Discrimination of physical hazards by meat products (from 2016 to 2018) according to consumers' complaints found on a Brazilian website.

Meat Product	Physical Hazard												
	Bone	Plastic	Insect	Metal	Hair	Foreign Object	Feather	Paper	Glass	Stone	Fabric	Wood	Rubber
Sausages	39 (+)	49 (+)[a]	10 (−)	14 (+)	5 (−)	8 (−)	0 (−)[a]	3 (−)	0 (−)[a]	3 (+)	2 (+)	1	2 (−)[a]
Hamburgers	28 (+)[a]	17 (−)	4 (−)	1 (−)[a]	10 (+)[a]	7 (+)	0 (−)	2 (−)	3 (+)	1 (−)	0 (−)	0 (−)	0 (−)
Fresh Chicken Meat	18 (+)	1 (−)[a]	7 (+)	4 (−)	2 (−)	2 (−)	13 (+)[a]	0 (−)	3 (+)	0 (−)	0 (−)	0 (−)	0 (−)
Chicken Nuggets	8 (−)	11 (+)	3 (−)	4 (+)	4 (+)	2 (−)	1 (+)	2 (+)	2 (+)	1 (+)	1 (+)	1 (+)	0 (−)
Ham	5 (+)	4 (+)	2 (+)	0 (−)	0 (−)	2 (+)	0 (−)	0 (−)	1 (+)	1 (−)	0 (−)	0 (−)	0 (−)
Minced Meat	6 (+)	2 (−)	1 (−)	1 (−)	0 (−)	1	0 (−)	4 (+)[a]	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)
Mortadella	0 (−)[a]	3 (−)	4 (+)[a]	6 (+)[a]	2 (+)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)
Hotdog Sausages	1 (−)	4 (+)	2 (+)	1 (−)	2 (+)	2 (+)	0 (−)	0 (−)	1 (+)	0 (−)	0 (−)	0 (−)	0 (−)
Bacon	0 (−)[a]	0 (−)[a]	6 (+)[a]	2 (+)	3 (+)[a]	1 (+)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)
Pattie	0 (−)	2 (+)	3 (+)[a]	0 (−)	0 (−)	1 (+)	0 (−)	0 (−)	0 (−)	0 (−)	1 (+)[a]	0 (−)	0
Meatballs	3 (+)	1 (−)	0 (−)	1 (+)	1 (+)	0 (−)	0 (−)	0 (−)	1 (+)[a]	0 (−)	0 (−)	0 (−)	0
Salami	1 (+)	4 (+)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	1 (+)[a]	0 (−)	0 (−)	0 (−)	1 (+)[a]	0
Kibbeh	0 (−)	1 (−)	0 (−)	1 (+)	1 (+)	2 (+)[a]	0 (−)	0 (−)	0 (−)	1 (+)[a]	0 (−)	0	0
Turkey Breast	0 (−)	2 (+)	0 (−)	1 (+)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0	0	0
Frozen Chicken Meat	0 (−)	0 (−)	2 (+)[a]	0 (−)	0 (−)	0 (−)	1 (+)[a]	0 (−)	0 (−)	0 (−)	0	0	0
Chopped Ham	0 (−)	2 (+)[a]	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0	0	0	0
Fresh Bovine Meat	0 (−)	0 (−)	1 (+)	0 (−)	1 (+)[a]	0 (−)	0 (−)	0 (−)	0 (−)	0	0	0	0
Fresh Pork Meat	1 (+)	0 (−)	1 (+)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0 (−)	0	0	0	0

[a] Effect of chi-square per cell. (+) or (−) indicate that the observed value is higher or lower than the expected theoretical value. *P < 0.05